DOCUMENT RESUME

ED 162 127 08 CE 018 414

AUTHOR Ghazalah, I. A.
TITLE Improving the Economic Assumption Factors in the Cost-Benefit Study Formulas for Ohio Vocational Education, or A System for the Evaluation of Investment in Vocational Education in Ohio. [Final Report].
INSTITUTION Ohio State Dept. of Education, Columbus. Div. of Vocational Education.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
BUREAU NO 498AH50209
PUB DATE Feb 78
GRANT G007501705
NOTE 67p.; Appendixes V-VIII removed because of marginal legibility; Not available in hard copy due to broken type in original document

EDRS PRICE MF-$0.83 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Computer Programs; *Cost Effectiveness; *Economic Factors; Evaluation Criteria; Evaluation Methods; Investment; Mathematical Models; *Program Costs; Program Evaluation; State Programs; Student Costs; *Systems Analysis; *Vocational Education
IDENTIFIERS Ohio

ABSTRACT

A localized system for the evaluation of investment in vocational education in Ohio is described in this four part manual. Following an instruction introduction to the manual, part II provides a description of the analytical framework for this system. Vocational education is analyzed as an investment and an explanation of the criteria used in the evaluation is given. The steps used in the computerized system to calculate the evaluation measures are listed in part III. It also lists the data and source of data utilized in each step. Part IV consists of appendixes which contain operational and informational material. Appendix I describes how to feed the necessary information to obtain the desired evaluation of investment in the training of an individual, while Appendixes II, III, and IV describe subprograms for calculations relating to steps shown in Appendix I. (JH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED162127

IMPROVING THE ECONOMIC ASSUMPTION FACTORS IN THE COST-BENEFIT STUDY FORMULAS FOR OHIO VOCATIONAL EDUCATION or a System for the Evaluation of Investment in Vocational Education in Ohio

BY

I. A. GHAZALAH

PROFESSOR OF ECONOMICS
OHIO UNIVERSITY

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

SUPPORTED BY FUNDS FROM THE STATE OF OHIO DEPARTMENT OF EDUCATION, DIVISION OF VOCATIONAL EDUCATION (AGREEMENT R-8-76) UNDER THE PROVISIONS OF PART C - RESEARCH AND TRAINING IN VOCATIONAL EDUCATION - OF THE VOCATIONAL EDUCATION AMENDMENTS OF 1968, PUBLIC LAW 88-210.

CFDA: 13.498A

DIVISION OF VOCATIONAL EDUCATION
DEPARTMENT OF EDUCATION, STATE OF OHIO
COLUMBUS, OHIO 43215

FEBRUARY, 1978

CE 018 414

Title of Project:	Improving the Economic Assumption Factors in the Cost-Benefit Study Formulas for Ohio Vocational Education
Applicant Organization:	Division of Vocational Education Department of Education State of Ohio Room 907 65 South Front Street Columbus, OH 43215
Project Director:	R. D. Balthaser, Assistant Director Division of Vocational Education Research, Survey, Evaluation and Exemplary Programs Room 904 Ohio Departments Building 65 South Front Street Columbus, OH 43215 614: 466-2095
Submitted by:	Byrl R. Shoemaker, Executive Director Vocational and Career Education and School Food Service
Federal Funds Used:	Total: $22,950.00 Grant #G007501705 OE #1316402047A7 Project #498AH50209
Duration:	July 1, 1975 - December 31, 1976
Time Span:	18 months
Date Transmitted:	June 23, 1978

SUMMARY

Project Title: Improving the Economic Assumption Factors in the Cost-Benefit Study Formulas for Ohio Vocational Education.

Project Dates: July 1, 1975 through December 31, 1976

Priority Area: This project is designated as Priority (B) Administration of Vocational Education at the local level.

Need and Problem: In the last few years, the justification for conducting Vocational Education programs has turned to the economic and labor interface problems. Ohio has had similar experiences as other states in trying to establish reports and information that would permit the Local Education Agencies (LEA) make better decisions. Two studies have been completed which bear on the reasons for the title:

A) The Role of Vocational Education in Improving Skills and Earning Capacity in the State of Ohio: A Cost-Benefit Study, I. A. Ghazalah, Department of Economics, Ohio University, November, 1972.

Note: Assumptions made in this study by necessity were from national norms and other studies of national characteristics.

B) Vocational Education Planning Districts in Ohio: An Economic Evaluation of Foregone Benefits from Limited Participation, I. A. Ghazalah, Department of Economics, Ohio University, February, 1974.

Note: Using the formulas designed in the first study, expansion and representative costs were employed in 55 taxonomies of Vocational Education and all 107 Vocational Education Planning Districts (VEPD).

A recommendation by the investigator of the cost-benefit studies (A and B) has been made and outlined to obtain economic and other cost factors that are based on area statistics for the various parts of Ohio.

An analysis of this series of activities has been undertaken by the Ohio Advisory Council with a contract at the Center for Vocational Education, The Ohio State University. Preliminary findings have zeroed in on the singular definitions and salary structures which cast suspicion on benefits, but at this time the report has no proposed solution other than this project.

1. OBJECTIVES AND NEED FOR THIS ASSISTANCE

Based on our own observations and finite problems within the above studies, the basis for this proposal is to:

a. Principally produce an area study of Ohio with resultant economic and human factors established to bring benefit studies, both personal and social, down to the levels of competency with the LEA's.

b. Produce a sample report from four (4) Vocational Education Planning Districts (VEPD) similar to former reports including costs obtained in the FY74 operating year and the new area basis.

c. Computerize the data base results by the SMSA, Appalachia, and rural Ohio areas in a print-out for distribution to LEA's for their use on an area economic base to compute benefits from any program it would offer its VEPD.

2. RESULTS OR BENEFITS EXPECTED

On the assumption that the data base in the existing cost-benefit formulas is more realistic for each VEPD, the expected benefit will be the ability of the LEA administrator to determine what the contribution value of the specific taxonomy in Vocational Education will be to his students and community.

Within the total system of the Ohio data base, this component will provide the base for administrative decisions locally through the Ohio Educational Data Systems provided by the State Department of Education (SDE).

3. APPROACH

The Plan - Basically, the operation consisted of sub-contracting to a proven investigator in the above series to develop the economic bases needed to complete the formulas for the various areas of Ohio. A preliminary report is made on four sample districts, and the total report will be programmed into the data system being designed and implemented within the RCU operation of the SDE at a later date.

a. Scope and detail - The present investigator of the cost-benefit studies in Ohio has delineated the economic and personal factors in Ohio rather than the national factors and assumptions. This data system is designed to be maintained in consistent classifications at the school and program level for use in the evaluation of vocational programs. The development of such a data system will make it possible to accumulate data in the form of a data bank--a data source directly aimed at analysis and evaluation.

One the data base is established and collected, sample VEPD analysis will be made, and finally all bases will be filed and accessed on a computer system with reports available to each LEA.

b. Kinds of data collected - based on the formula already in use:
   1) Handbook VI Taxonomy Codes
   2) Building Costs
   3) Building Life
   4) Number of Pupils
   5) Duration of program
   6) Vocational Program Equipment Costs
   7) Equipment Life

8) School District Type (Local, City, Village, JVS)
9) Current School Costs - SDE Vocational Education Cost Analysis, Annual
10) Geographical Location Code - County or SMSA
11) Hourly Wage - minimum
12) After Tax Income Factor
13) Beginning Hourly Wage of Vocational Education Graduate
14) Employment Rate
15) Cooperative Student Earnings
16) Sex
17) Labor Force Participation by age, sex, and county
18) Age-Specific Probability of Survival by sex and color
19) Vocational Education Trainee's out-of-pocket expenses
20) Per Capita Income Relatives
21) Annual Academic Costs Per Pupil

c. Evaluation and dissemination - evaluation of the product was made by a comparative analysis of the four districts with the same information of the 1972 study in those districts.

Dissemination will be to the USOE with additional reports to the other 55 RCU units when published.

d. Conclusions - At the present time, the project was not completed to the level of placing the system on-line in the SDE computer. The new computer is in place, but is beyond capacity, so no effort has been made to put such a system as this in place, but will be considered in the future.

1) Such a system as this is expected to be used by LEA planners in their vocational education planning.
2) The SDE computer system is available by contract to any eligible recipient, to CETA sponsors, and other State agencies. Therefore, this formula will assist other planners if they can accept the base data in each of the components utilized.
3) Computer tapes are on file as a product that can be duplicated for other states to use, but data sources will have to be non-Ohio generated by other states unless they can accept Ohio's data. IBM370-Fortran
4) As the inefficient LEA system is turned inward to larger planning districts, the resources available will trigger the use or non-use of this system. The larger the district in Vocational Education Planning, the more sophisticated, computerized, and planning oriented they become. As this happens, this system will come into play.

e. Recommendations - This system can be replicated by any state. In Ohio, it is recommended that it be implemented as soon as disk space and programmer time is available to move the program into real-time condition from present tape environment.

4. GEOGRAPHIC LOCATION

Primary location will be at the State Department of Education, Division of Vocational Education, Room 904, 65 South Front Street, Columbus, Ohio 43215 in the 15th Congressional District.

5. BIOGRAPHICAL SKETCHES - Personnel involved:

R. D. Balthaser - BS, 1950; MA, 1952, The Ohio State University; Assistant State Director, Division of Vocational Education in charge of Research, Survey, Evaluation and Exemplary Programs, 1973--; State Supervisor and Assistant Director of Business and Office Education, 1957-1973; Business Education teacher, 1951-1957; Junior Accountant, 1945-1951; Lancaster Business College, 1939-1942; USNR NtSch(RM) as Ylc, 1942-1945.

I. A. Ghazalah - PhD, University of California; background in economics and public finance including studies in intergovernmental transfers, population mobility, school expenditures, university tuition differentials, international differences in taxes and income redistribution, municipal income taxes, and vocational education benefit studies. Currently chairman of the Department of Economics, College of Business Administration, Ohio University, Athens, Ohio

TABLE OF CONTENTS

		Page
	Summary of Project	i
	Table of Contents	v
I.	A Localized System for the Evaluation of Investment in Vocational Education in Ohio: General Introduction	1
II.	The Analytical Framework: Evaluation of Investment in Vocational Education	3
	A. Introduction	3
	B. The Criteria	5
	Rate of Return	6
	i. Rate of Return I	8
	ii. Rate of Return II	13
	Present Value	15
	i. Present Value I	16
	ii. Present Value II	20
III.	Program Procedure (Algorithm)	22
IV.	Appendices	42
	Appendix I Procedure for Keying Information	43
	Appendix II Subprogram for Calculation of Lifetime Labor Force Participation Rates	50
	Appendix III Subprogram for Calculation of Age-Specific Probability of Survival	52
	Appendix IV Subprogram for Calculation of Present Value and Rate of Return	55
	Appendix V Geographical Location Codes	60
	Appendix VI List of Vocational Program Taxonomy Codes	63
	Appendix VII Data Formats	73
	Appendix VIII Sample Printouts	76

I

A LOCALIZED SYSTEM FOR THE EVALUATION OF INVESTMENT IN VOCATIONAL EDUCATION IN OHIO: GENERAL INTRODUCTION

The purpose of this monograph is to describe and serve as a manual for the use of a system designed for evaluating investment in vocational education programs in the State of Ohio.

The computerized system makes it possible to calculate the *rate of return* and the *present value* of investment in the training of an individual in a vocational program.

The use of the system is rather uncomplicated. It merely requires punching as few as one card (see Appendix I: Procedure for Keying Information). It does require, however, continuous updating of data in the Data Library. New data need to be obtained from a variety of sources and incorporated in the required format (see Appendix VII: Data Formats).

The system is a dynamic one. Where *ideal* data are not available, the program uses an adaptation of available data to approximate the *ideal* data. As better data become available, their inclusion is allowed for and requires no basic change in the system.

Part II provides the analytical framework for the system. Vocational education is analyzed as an investment and a detailed explanation of the criteria used in the evaluation is given.

Part III lists the steps used in the computerized system in order to calculate the evaluation measures. It also lists the data and the source of data utilized in each step.

Part IV is made up of seven appendices which contain operational or informational material. Appendix I, *Procedure for Keying Information*, describes how to feed the necessary information to obtain the desired evaluation of investment in the training of an individual. The necessary information includes the individual's sex, the program's taxonomy code, the type of school district (city, local, exempted village, or vocational), the duration of the program (in years), and the geographical location of the program (county or combination of counties). Appendices II, III, and IV describe subprograms for calculations relating to steps shown in the *Program Procedure*. Appendices V and VI list the geographical location codes and the vocational program taxonomy codes, while Appendix VII shows the data formats used the computerized system.

II

THE ANALYTICAL FRAMEWORK: EVALUATION OF INVESTMENT IN VOCATIONAL EDUCATION

A. Introduction

Vocational education is a form of investment in men and women--the human resource which, in combination with non-human resources, produces the economy's goods and services. In this context, vocational education performs the function of *upgrading* the supply of human resources and consequently enhances their contribution to the production of goods and services.

As investment options, vocational education programs may be appraised by utilizing cost-benefit analysis, a technique that allows the analyst to determine whether or not a particular investment is worthwhile as well as how worthwhile one investment is relative to another.

The concept of cost benefit analysis reflects a rudimentary decision rule: a rational decision-maker could be expected to undertake an activity only if anticipated benefits exceed anticipated costs. The determination of benefits and costs, however, is dependent upon the *objectives* of the activity. Once the objectives are specified, benefits consist of the contribution to the objectives that will emerge from the activity. Costs are what must be given up as a consequence of engaging in the activity, i.e. the "opportunity cost" of the resources used.

The *objectives* of vocational education, like those of all forms of education, are multi-dimensional. An all-encompassing goal such as improvement of well-being (or *welfare*) includes a number of components: First, participants in the educational process enjoy education for its own sake. Moreover, education

enables those who participate in it to achieve greater or more varied enjoyment in the future. Education, therefore, has an objective of future as well as immediate use as a *consumption good*. A second possible objective of education is increasing the *participation* of individuals in society. The accomplishment of a personal goal (completion of an educational program) enhances self-confidence and acceptance and thereby contributing to greater social participation. Third, education may have the objective of decreasing inequality in economic opportunity by making it possible for those who possess less *non-human* wealth to increase their *human* wealth and thereby enabling them to improve their economic position. Fourth, education has a major objective of raising the productivity of men and women as a human resource and consequently increasing the output of goods and services in the economy. This renders education as an *investment good* in addition to its value as a *consumption good*.

An ideal evaluation of educational programs requires the specification of a single functional relationship which uniquely encompasses all of these objectives. The quantification of all variables in such a comprehensive function remains beyond the realm of possibility, given the current state of the art. Of necessity, therefore, the analysis must be narrowed to those variables that are measurable in a common unit.

Since vocational education is principally aimed at increasing the productivity of human resources, the system developed in this study will limit itself to an evaluation of vocational education as an *investment good*, i.e. in terms of its contribution to the objective of raising the output of goods and services in the economy as measured by the increase in the earning power of participants in vocational education.

B. The Criteria

Evaluation of investment in the vocational education of an individual requires the use of an investment criterion--a measure that allows a determination of (1) whether or not the investment is worthwhile, and (2) how worthwhile is the investment relative to other investment options.

Training of an individual in each vocational program may be viewed as an investment option. Decisions on investment options involve three elements: *costs, benefits,* and *time*. Benefits (and often costs) of an investment occur through time. When the investment decision is being contemplated, the benefits (and costs) that occur in the future must be related to the present. Future benefits (and costs) have a lower value than the same benefits (or costs) available at present. This is due to two principal factors: First, a dollar available today will yield more than one dollar in the future due to the productivity of investment. Consequently, a future dollar must be valued as being worth less than a dollar today. Second, the principle of positive time preference. The ultimate purpose of economic activity is consumption. Since individuals dislike postponing consumption, the value of a future dollar is less than that of a dollar available today. The upshot of these two factors is that future benefits (and costs) from today's investment decisions must be discounted (evaluated in terms of their present worth) in order to give different weights to benefits and costs depending on the investment's time profile magnitudes of benefits and costs during each period).

The system developed in this study appraises investment in vocational education using two criteria: (1) the *rate of return* which measures the profitability rate on the investment and (2) the *present value*, which measures the excess of benefits from the investment over its costs.

Rate of Return

The rate of return is that rate which makes discounted costs equal the discounted value of benefits. If we denote the benefits derived from the investment by B and costs by C and use subscript t to indicate the duration of the investment in time periods (years), then the rate of return r in the following equation is the percentage we wish to determine for the investment in question:

$$\sum_{t=0}^{n} \frac{C_t}{(1+r)^t} = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} \qquad (1)$$

If costs are incurred in a single time period (t_o), while benefits continue over a number of subsequent time periods ($t_1, t_2, \ldots, t_n$), the equation becomes:

$$C_o = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} \qquad (2)$$

or

$$\sum_{t=1}^{n} B_t(1+r)^{-t} - C_o = 0 \qquad (3)$$

The calculated rate of return (r) is then compared against a rate of *interest* (i) which measures the opportunity cost of the funds used in undertaking the investment. An investment is considered worthwhile so long as its rate of return r exceeds the rate of interest i. However, when a budget constraint exists, all investments with rates of return exceeding the rate of interest can be ranked in terms of their rates of return. The decision-makers then can adopt these investment options in order of their rates of return until the budget is exhausted.

The system allows calculation of rates of return on investment in a specific vocational program. Separate calculations may be obtained: (1) the *private rate of return*, i.e. the rate of return to the trainee alone based on benefits and costs applicable to the trainee as an investor in himself or herself, and (2) the *social rate of return*, i.e. the rate of return to society in its investment in the vocational education of an individual, based on benefits derived and costs incurred by society at large.

In the calculation of *social* as well as *private* rates of return, two distinct measures of rates of return are computed on the basis of two possible alternatives to participation in vocational education at the eleventh and twelvth grade level. Under the first measure (*Rate of Return I*) rates of return are calculated on the assumption that except for enrollment in the vocational program, the individual would have dropped out of high school and entered the labor market upon completion of the tenth grade. *Rate of Return I*, therefore, views vocational education as an investment in high-school dropout prevention and the computed figure indicates the rate of return on that investment.

The second measure (*Rate of Return II*) indicates the rate of return on training in a vocational program *in lieu of* completing the eleventh and twelfth grades in an academic curriculum. *Rate of Return II*, therefore, evaluates training in a vocational program, as an alternative to academic high school education.

As Equation (3) shows, there are three elements in the calculation of the rate of return: *benefits*, *costs*, and *time* (the lifetime of the investment, i.e. the number of time periods during which the flow of benefits and costs is expected to occur).

Costs are considered to be incurred in a single *time* period--the initial period t_o. The duration of the flow of benefits is considered differently under

the two measures: Rate of Return I and Rate of Return II. As a measure of *benefits* from vocational education (as well as foregone benefits during training), the system uses earnings. Therefore, it relies upon two indices: wage rates and the percentage of time the trainee or graduate is employed.

The following is an explanation of how these three elements--costs, benefits, and time--are allowed for in the calculation of social and private rates of return using both measures: Rate of Return I and Rate of Return II. Table 1 provides a convenient summary.

i. Rate of Return I

Under the dropout alternative, vocational education is viewed as an investment in an individual who otherwise would have left school upon completion of the tenth grade and entered the labor market.

The *social rate of return* (S_r) is calculated using the following formula:

$$\sum_{t=1}^{n} SB_t \ (1 + S_r)^{-t} - SC_o = 0 \qquad (4)$$

where S_r = the social rate of return,

SC = social costs,

SB = social benefits, and

n = years of working lifetime.

Social costs (SC) are costs of the investment to society at large. They include *direct costs* incurred by the school and *indirect costs* (opportunity costs of non-school inputs). Indirect costs represent the foregone earnings of the trainee and thus measure the value of output that the trainee would have contributed (for the duration of his or her training) if he or she had entered

TABLE 1

COSTS AND BENEFITS OF VOCATIONAL EDUCATION

AND CALCULATION OF RATE OF RETURN

SOCIAL	PRIVATE
1. COSTS	1. COSTS
Definition: opportunity costs to society at large (welfare foregone to society from the use of the resources in the vocational program rather than in the production of other goods and services).	Definition: opportunity costs to the individual (welfare foregone to the individual from the use of the resources in the vocational program rather than on other goods and services).
Components:	Components:
Rate of Return I	Rate of Return I
1. Direct costs: costs incurred by the school in providing the specific vocational training: a. current costs b. capital costs	1. Direct costs: costs incurred by the individual due to enrollment in the vocational program (e.g., books, tools).
2. Indirect costs: opportunity costs of non-school inputs: a. foregone earnings of the trainee during training	2. Indirect costs: opportunity costs to the individual of enrollment in the vocational program: a. foregone earnings net of taxes

Rate of Return II

1. Direct costs: costs incurred by the school in providing the specific vocational training over and above the cost that would have been incurred by an academic high school:
   a. current costs
   b. capital costs

2. BENEFITS

Definition: Welfare gained by society at large from the individual's training in the vocational program.

Components:

Rate of Return I

1. increased output attributable to the individual's training in the vocational program.

Rate of Return II

1. output attributable to the individual's training in the vocational program over and above the output that would have been realized had the

Rate of Return II

1. Direct costs: costs incurred by the individual due to enrollment in the vocational program (e.g., books, tools).

2. BENEFITS

Definition: Welfare gained by the individual from training in the vocational program.

Components:

Rate of Return I

1. increased earnings attributable to the individual's training in the vocational program.

Rate of Return II

1. earnings attributable to the individual's training in the vocational program over and above the earnings that would have been realized had the

individual completed an academic high school education.

3. TIME

Definition: Lifetime of the investment, i.e. the number of time periods during which the flow of benefits and costs is expected to occur.

Components:

Rate of Return I

1. Costs considered to have been incurred in a single period (the initial time period t_o).
2. Benefits considered to occur over the working lifetime of the individual

Rate of Return II

1. Costs considered to have been incurred in a single period (the initial time period t_o).
2. Benefits considered to occur over the five years following graduation from a vocational program.

individual completed an academic high school education (net of taxes).

3. TIME

Definition: lifetime of the investment, i.e. the number of time periods during which the flow of benefits and costs is expected to occur.

Components:

Rate of Return I

1. Costs considered to have been incurred in a single period (the initial time period t_o).
2. Benefits considered to occur over the working lifetime of the individual

Rate of Return II

1. Costs considered to have been incurred in a single period (the initial time period t_o).
2. Benefits considered to occur over the five years following graduation from a vocational program.

the labor market rather than enrolled in a specific vocational program. This cost of foregone output is calculated by subtracting from the annual potential earnings as a high school dropout, the annual earnings from part-time employment during training and multiplying the difference by the number of years the trainee spends in the program.

The direct costs incurred by the school comprise *current costs* (operation and maintenance) and *capital costs* (costs of buildings and equipment). The average total cost (total cost per trainee) per annum is computed for the vocational program by summing the per annum average current cost and average capital cost and multiplying the sum by the duration of the vocational program.

Social benefits are considered to be the difference between earnings of a graduate of a specific vocational program and average earnings of an individual with a tenth grade schooling over the working lifetime.

Benefits for the first year are calculated by subtracting yearly earnings as a high school dropout with tenth grade education, from the average first year earnings for graduates of the vocational program. For subsequent years, it is assumed that wage rates of vocational graduates increase at the rate of three per cent per year, while wage rates of non-trainees increase at a higher rate so that the gap between earnings of high school dropouts and vocational high school graduates at the end of the working lifetime diminish to fifteen per cent of its initial level. The rationale behind the assumption of a narrowing of earnings differential is the availability of on-the-job training and labor union effectiveness in wage-rate determination. For each sex and at each age, earnings are then adjusted by multiplying potential earnings by probabilities for survival and of labor force participation.

The *private rate of return* (P_r) is calculated using the following formula:

$$\sum_{t=1}^{n} PB_t (1 + P_r)^{-t} - PC_o = 0 \qquad (5)$$

where P_r = the private rate of return,

PC = private costs,

PB = private benefits, and

n = number of years of working lifetime.

Private costs are those incurred by an individual as an investor in himself or herself. They include (1) direct costs to the trainee, and (2) the trainee's foregone earnings during training. Direct costs are expenses for tools and other out-of-pocket expenses attributable to enrollment in the vocational program. Foregone earnings during training represent the trainee's opportunity cost of enrollment in the specific vocational program. This is the same foregone earnings figure used in the calculation of social costs except that it is computed net of state and federal taxes on the basis of average tax rates, for the earnings range.

Private benefits (PB) differ from social benefits only in that earnings for each year are computed net of taxes.

ii. Rate of Return II

In this measure of the rate of return, vocational education is viewed as an alternative to academic high school education.

The *social rate of return* (S_r^*) is calculated using the following formula:

$$\sum_{t=1}^{n} SB_t^* (1 + S_r^*)^{-t} - SC_o^* = 0 \qquad (6)$$

where S_r^* = the social rate of return,

SC* = social costs,

SB* = social benefits, and

n = five years.

Social costs (SC*), the cost to society of investment in the individual, in this case amounts to the *difference* in cost to the public educational system of providing training in a particular vocational program and of providing education in an academic high school.

Social benefits (SB*) are considered to be the difference between earnings of a graduate of a particular vocational program *and* earnings of an academic high school graduate. These earnings are subtracted from the average earnings of a graduate of the specific vocational program to obtain the first year's benefits. An annual growth rate of three per cent in the wage rate of the vocational graduate is assumed thereafter and a higher growth rate for the academic high school graduate such that the entire earnings differential is eliminated by the end of the fifth year following graduation. The rationale for this assumption is that since the number of years of schooling is virtually the same under both investment options, the earnings differential will be eliminated primarily through on-the-job training.

The *private rate of return* (P_r^*) is calculated using the following formula:

$$\sum_{t=1}^{n} PB_t^* (1 + P_r^*)^{-t} - PC_o^* = 0 \qquad (7)$$

where P_r^* = the private rate of return,

PC* = private costs,

PB* = private benefits, and

n = five years.

No loss of earnings during training is included under this measure of the rate of return, since the assumption is that the trainee would have been enrolled in an academic high school rather than have entered the labor market as in the case of Rate of Return I. The only private costs (PC*), therefore, are the trainee's direct costs: expenses for tools and other out-of-pocket expenses specifically attributable to enrollment in the vocational program.

Private benefits (PB*) are considered to be the difference between earnings as a vocational program graduate and earnings as an academic high school graduate. They are equivalent to social benefits SB* except for the tax adjustment.

Present Value

The present value measures the excess of benefits from the investment over its costs with the proper weighting of benefits and costs according to the applicable time profile.

The present value V is obtained using the following equation:

$$V = \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} - C_o \qquad (8)$$

where V = the present value,

C = costs,

B = benefits,

i = discount rate (the opportunity cost of funds used in the investment, and

t = duration of the investment in time periods (years).

A positive number (i.e. greater than 0) for V_o indicates that the investment is worthwhile in an absolute sense, i.e. the benefits derived exceed the costs.

The system allows calculation of the present value of an investment (1) to the trainee alone based on benefits and costs applicable to the trainee as an investor in himself or herself, i.e. the *private present value* and (2) to society in its investment in the vocational education of an individual, based on benefits and costs incurred by society at large, i.e. the *social present value.*

As in the case of the rate of return criterion, two distinct present values are computed on the basis of two possible alternatives to participation in a vocational program at the eleventh and twelfth grade level. *Present Value I* measures the value of investment in the vocational program as an alternative to dropping out of high school upon completion of the tenth grade. *Present Value II* evaluates the investment in the vocational program *in lieu of* completing the eleventh and twelvth grades in an academic curriculum.

Table 2 shows in summary form how costs, benefits, and time are allowed for in the calculation of social and private present value using both measures: Present Value I and Present Value II.

i. Present Value I

The *social present value Method I* (S_v) using the following formula:

$$S_v = \sum_{t=1}^{n} SB_t \ (1+i)^{-t} - SC \qquad (9)$$

where S_v = the social present value,

SC = social costs,

SB = social benefits,

i = discount rate, and

n = years of working lifetime.

TABLE 2

COSTS AND BENEFITS OF VOCATIONAL EDUCATION

AND CALCULATION OF PRESENT VALUE

SOCIAL	PRIVATE
1. COSTS	1. COSTS
Definition: opportunity costs to society at large (welfare foregone to society from the use of resources in the vocational program rather than in the production of other goods and services).	Definition: opportunity costs to the individual (welfare foregone to the individual from the use of resources in the vocational program rather than on other goods and services).
Components:	Components:
Present Value I	Present Value I
1. Direct costs: costs incurred by the school providing the specific vocational training: a. current costs b. capital costs	1. Direct costs: costs incurred by the individual due to enrollment in the vocational program (e.g. books, tools)
2. Indirect costs: opportunity costs of non-school inputs: a. foregone earnings of the trainee during training	2. Indirect costs: opportunity costs to the individual of enrollment in the vocational program: a. foregone earnings net of taxes

Present Value II

1. Direct costs: costs incurred by the school in providing the specific vocational training over and above the cost that would have been incurred by an academic high school:
   a. current costs
   b. capital costs

Present Value II

1. Direct costs: costs incurred by the individual due to enrollment in the vocational program (e.g. books, tools).

2. BENEFITS

Definition: welfare gained by society at large from the individual's training in the vocational program.

Components:

Present Value I

1. Increased output attributable to the individual's training in the vocational program.

Present Value II

1. Increased output attributable to training in the vocational program over and above potential output increase from completing an academic high school education.

2. BENEFITS

Definition: welfare gained by the individual from training in the vocational program.

Components:

Present Value I

Increased earnings attributable to the individual's training in the vocational program.

Present Value II

1. Increased earnings attributable to training in the vocational program over and above potential earnings increase from completing an academic high school education.

3. TIME

Definition: lifetime of the investment, i.e. the number of time periods during which the flow of benefits and costs is expected to occur.

Components:

Present Value I

1. Costs considered to have been incurred in a single period (the initial time period t_0).
2. Benefits considered to occur over the working lifetime of the individual.

Present Value II

1. Costs considered to have been incurred in a single period (the initial time period t_0).
2. Benefits considered to occur over the five years following graduation from a vocational program.

3. TIME

Definition: lifetime of the investment, i.e. the number of time periods during which the flow of benefits and costs is expected to occur.

Components:

Present Value I

1. Costs considered to have been incurred in a single period (the initial time period t_0).
2. Benefits considered to occur over the working lifetime of the individual.

Present Value II

1. Costs considered to have been incurred in a single period (the initial time period t_0).
2. Benefits considered to occur over the five years following graduation from a vocational program.

The *private present value Method I* (P_v) using the following formula:

$$P_v = \sum_{t=1}^{n} PB_t \ (1+i)^{-t} - PC \qquad (10)$$

where P_v = the private present value,

PC = private costs,

PB = private benefits,

i = discount rate, and

n = years of working lifetime.

ii. Present Value II

The *social present value Method II* (S_v^*) is calculated using the following formula:

$$S_v^* = \sum_{t=1}^{n} SB_t^* \ (1+i)^{-t} - SC^* \qquad (11)$$

where S_v^* = the social present value,

SC* = social costs,

SB* = social benefits,

i = discount rate, and

n = five years.

The *private present value Method II* (P_v^*) is calculated using the following formula:

$$P_v^* = \sum_{t=1}^{n} PB_t^* \ (1+i)^{-t} - PC^* \qquad (12)$$

where P_v^* = the private present value,

PC = private costs,

PB = private benefits,

i = discount rate, and

n = five years.

III

PROGRAM PROCEDURE

(ALGORITHM)

Basic Program	Data Library
(1) TAXONOMY CODE (Vocational Program) KEYED*	Data Source: State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, General Information of Vocational Education (GIVE) Listing, Taxonomy List.
(2) BUILDING COSTS	Data Source: State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, Facilities Computation.
(3) BUILDINGS LIFE	Data Source: Figure of 33 (years) is used in the program.

* The term "keyed" indicates that the appropriate figure is to be externally programmed by the user. See Appendix I for further explanations and keying procedure.

(4)	NUMBER OF PUPILS (in the vocational program)	Data Source: State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, A System for Analyzing the Cost of Operating Vocational Education Programs at the Secondary Level in Ohio, Annual, table entitled "Summary of Secondary Vocational Education Instruction Program Costs."
(5)	DURATION OF VOCATIONAL PROGRAM (in years) KEYED*	Data Source: Punch 1 for one-year program. Punch 2 for two-year program.
(6)	NUMBER OF GRADUATES FROM VOCATIONAL PROGRAM (per year) (4) ÷ (5)	
(7)	VOCATIONAL PROGRAM'S BUILDINGS COSTS (per year) (2) ÷ (3)	

(8)	VOCATIONAL PROGRAM'S ANNUAL BUILDINGS COSTS (per graduating trainee) (7) ÷ (6)	
(9)	VOCATIONAL PROGRAM'S EQUIPMENT COSTS	Data Source: State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, A System for Analyzing the Cost of Operating Vocational Education Programs at the Secondary Level in Ohio, Annual, table entitled "Equipment Depreciation Table for Program and Class for One Year."
(10)	VOCATIONAL PROGRAM'S EQUIPMENT LIFE (in years)	Data Source: State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, A System for Analyzing the Cost of Operating Vocational Education Programs at the Secondary Level in Ohio, Annual, table entitled "Equipment Depreciation Table for Program and Class for One Year."

(11) VOCATIONAL PROGRAM'S EQUIPMENT COSTS (per year)

(9) ÷ (10)

---

(12) VOCATIONAL PROGRAM'S ANNUAL EQUIPMENT COSTS (per graduating trainee)

(11) ÷ (6)

---

(13) SCHOOL DISTRICT TYPE KEYED*

Data Source:

Punch 1 for Local School District.

Punch 2 for City School District.

Punch 3 for Exempted Village School District.

Punch 4 for Joint Vocational School District.

---

(14) VOCATIONAL PROGRAM'S CURRENT SCHOOL COSTS (Annual per pupil)

Data Source:

State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, A System for Analyzing the Cost of Operating Vocational Education Programs at the Secondary

Level in Ohio, Annual, table entitled "Summary of Secondary Vocational Education Instructional Program Costs."

The appropriate annual current school costs per pupil are calculated by subtracting "Voca. Shop Lab Equip." from "Total Cost" (Shop Lab Equip. Costs are included in Vocational Program's Equipment Costs (9)).

---

(15) VOCATIONAL PROGRAM'S ANNUAL CURRENT SCHOOL COSTS (per graduating trainee)

(14) x (5)

---

(16) VOCATIONAL PROGRAM'S TOTAL SCHOOL COSTS (per graduating trainee)

(15) + (12) + (8)

---

(17) VOCATIONAL PROGRAM'S GEOGRAPHICAL LOCATION CODE KEYED*	Data Source: See Appendix V entitled "Geographical Location Codes." Appendix V lists codes for all counties and Standard Metropolitan Statistical Areas (SMSA's) in Ohio. To obtain calculations for an individual county or SMSA, punch the designated code. Calculations for any combination of counties and/or SMSA's may be obtained by punching each of the relevant codes (see Appendix I for explanation of procedure). The program will then execute separate calculations for each of the included counties and/or SMSA's as well as for the desired combination of counties and/or SMSA's.
(18) HOURLY WAGE OF HIGH SCHOOL DROPOUT AGE 18 OR OVER (By Geographical Location)	Data Source: Federal minimum wage weighted by the per capita income relative for the geographical location (see (47)).
(19) EMPLOYMENT RATE OF HIGH SCHOOL DROPOUT AGE 18 OR OVER	Data Source: Figure of .80 is used in the program.

(20) GROSS ANNUAL EARNINGS OF HIGH SCHOOL DROP-OUT AGE 18 OR OVER

(18) x (19) x 40 x 52

---

(21) AFTER TAX INCOME FACTOR

Data Source:

(i) State Tax Rates

State of Ohio Department of Taxation, Columbus, Ohio, The Annual Report of the Ohio Department of Taxation, Annual, Table No. 5.6 entitled "(Year) Ohio Personal Income Tax Returns by Income Class."

The appropriate tax rates may be obtained by dividing "Tax Liability After Credits" by "Total Federal Adjusted Gross Income (less deficits)" for each of the 29 income classes listed in the table.

(ii) Federal Tax Rates

U. S. Department of the Treasury, Internal Revenue Service, Washington, D. C., Statistics of Income: Individual Tax Returns, table entitled "Selected Items by Size of Adjusted Gross Income and States and Regions."

The appropriate tax rates may be obtained, using Ohio data, by dividing "Total Income Tax"

by "Adjusted Gross Income (less deficits)" for each of the 23 income classes listed in the table.

The program will add the state and federal tax rates from each of the appropriate income classes and calculate an after-tax income factor (1 - t, where t is the combined federal and state tax rate) for each of the consolidated income brackets.

---

(22) ANNUAL AFTER-TAX EARNINGS OF HIGH SCHOOL DROPOUT AGE 18 OR OVER

(20) x (21)

---

(23) HOURLY WAGE OF HIGH SCHOOL DROPOUT BELOW AGE 18 (By Geographical Location)

Data Source:

A figure of .80 x (18) is used in the program (where (18) is the hourly wage of high school dropout age 18 or over, by geographical location).

---

(24) EMPLOYMENT RATE OF HIGH SCHOOL DROP-OUT BELOW AGE 18

Data Source:

A figure of .75 is used in the program.

---

(25) GROSS ANNUAL EARNINGS OF HIGH SCHOOL DROP-OUT BELOW AGE 18

(23) x (24) x 40 x 52

---

(26) ANNUAL AFTER-TAX EARNINGS OF HIGH SCHOOL DROPOUT BELOW AGE 18

(25) x (21)

---

(27) BEGINNING HOURLY WAGE OF GRADUATE OF VOCATIONAL PROGRAM

Data Source:

U. S. Department of Labor, Bureau of Labor Statistics, Washington, D. C., Area Wage Surveys.

Vocational Programs are matched with occupations listed in Area Wage Surveys. When no corresponding occupation is listed, an index is used reflecting relative earnings (See Appendix VI).

Area Wage Surveys cover the Ohio Standard Metropolitan Statistical Areas of Akron, Canton,

Cincinnati, Cleveland, Columbus, Dayton, Toledo, and Youngstown-Warren. The SMSA data are used as a basis for individual county data as follows:

1. For all counties in SMSA Area Wage Surveys, the applicable SMSA data are used. For counties outside the SMSA Area Wage Surveys, the Columbus SMSA data are used.

2. The wage figure for a specific vocational program in a specific county is obtained by multiplying the applicable SMSA wage figure (see item 47) as follows:

$$\frac{W \times I_1}{I_2}$$

where W = the wage of the vocational program's graduate in the applicable SMSA,

I_1 = the income relative for the county, and

I_2 = the income relative for the applicable SMSA.

---

(28) EMPLOYMENT RATE OF GRADUATE OF VOCATIONAL PROGRAM

Data Source:

Figure of .94 (94%) is used.

---

(29) FIRST YEAR'S GROSS EARNINGS OF VOCATIONAL GRADUATE

(27) x (28) x 40 x 52

---

(30) FIRST YEAR'S AFTER-TAX EARNINGS OF VOCATIONAL GRADUATE

(29) x (21)

---

(31) ANNUAL IN-SCHOOL EARNINGS (DURING TRAINING) OF VOCATIONAL TRAINEE

Data Source:

Figure of $1,200 is used.

---

(32) GROSS ANNUAL IN-SCHOOL AND SUMMER EARNINGS OF VOCATIONAL TRAINEE

(31) +[(23) x (24) x 40 x 14]

---

(33) AFTER-TAX ANNUAL IN-SCHOOL AND SUMMER EARNINGS OF VOCATIONAL TRAINEE

(32) x (21)

---

(34) FIRST YEAR'S SOCIAL BENEFITS FROM TRAINING OF VOCATIONAL GRADUATE

(29) - (20)

---

(35) FIRST YEAR'S PRIVATE BENEFITS FROM TRAINING OF VOCATIONAL GRADUATE

(30) - (22)

---

(36) SEX CODE KEYED*

Data Source:

Punch 1 for information relating to males.

Punch 2 for information relating to females.

Punch 3 for information relating to males and females combined (See Appendix I).

---

(37) LABOR FORCE PARTICIPATION RATES BY AGE, SEX, AND COUNTY

Data Source:

U. S. Department of Commerce, Bureau of the Census, Washington, D. C., General Social and Economic Characteristics, Ohio, Decennial, Table 121

(See Appendix II Subprogram for Calculation of Lifetime Labor Force Participation Rate)	entitled "Employment Characteristics for Counties."
(38) AGE-SPECIFIC PROBABILITY OF SURVIVAL BY SEX AND COLOR (See Appendix III: Subprogram for Calculation of Age-Specific Probability of Survival)	Data Source: (i) Resident Deaths State of Ohio, Department of Health, Columbus, Ohio, "Resident Deaths, Classified by Sex, Color, and Age Group, Each County and Ohio," Annual. (ii) Population U. S. Department of Commerce, Bureau of the Census, Washington, D. C., Characteristics of the Population, Ohio, Decennial, Table 35 entitled "Age by Race and Sex for Counties."
(39) AGE-SPECIFIC EFFECTIVE LABOR PARTICIPATION RATE DURING VOCATIONAL GRADUATE'S WORKING LIFETIME (AGE 19 TO RETIREMENT) (37) x (38) by age	42

(40) VOCATIONAL TRAINEE'S ANNUAL OUT-OF-POCKET EXPENSES

Data Source:

State of Ohio, Department of Education, Division of Vocational Education, Columbus, Ohio, table entitled "Approximate Student Costs."

Data are listed by taxonomy code. If no figure on out-of-pocket expenses is given, an average for the taxonomy code category is calculated and used.

---

(41) SOCIAL COST OF TRAINING THE VOCATIONAL GRADUATE (METHOD I)

$[(25) - (32)] \times (5) + (16)$

---

(42) PRIVATE COST OF TRAINING THE VOCATIONAL GRADUATE (METHOD I)

$[(26) - (33)] \times (5) + (40)$

---

(43) SOCIAL PRESENT VALUE AND SOCIAL RATE OF RETURN (METHOD I)

(See Appendix IV Subprogram for Calculation of Present Value and Rate of Return)

---

(44) PRIVATE PRESENT VALUE AND PRIVATE RATE OF RETURN (METHOD I)

(See Appendix IV Subprogram for Calculation of Present Value and Rate of Return)

---

(45) HOURLY WAGE OF GRADUATE OF ACADEMIC HIGH SCHOOL PROGRAM

Data Source:

The minimum federal wage figure is used in the program.

---

(46) EMPLOYMENT RATE OF GRADUATE OF ACADEMIC HIGH SCHOOL

Data Source:

Figure of .88 (88%) is used in the program.

---

(47) PER CAPITA INCOME RELATIVES

Data Source:

U.S. Bureau of Economic Analysis, Regional Economic Information System, Per Capita "Income Relatives by SMSA's and Counties (Residence Adjusted), Per Cent of National Income, Ohio", Annual.

---

(48) FIRST YEAR GROSS EARNINGS OF GRADUATE OF ACADEMIC HIGH SCHOOL

(45) x (46) x 40 x 52

---

(49) FIRST YEAR'S AFTER-TAX EARNINGS OF GRADUATE OF ACADEMIC HIGH SCHOOL

(48) x (21)

---

(50) FIRST YEAR'S SOCIAL BENEFITS (METHOD II)

(29) - (48)

---

(51) FIRST YEAR'S PRIVATE BENEFITS (METHOD II)

(30) - (49)

---

(52) ANNUAL ACADEMIC SCHOOL COSTS PER PUPIL (By School District Type and County)

Data Source:

State of Ohio, Department of Education, Division of Computer Services and Statistical Reports, Columbus, Ohio, Costs per Pupil, Annual.

Data are given by county and by school district type (city, local, exempted village, joint vocational).

If data are not reported for a specific county, the program will generate the required figures as follows:

(i) If the missing figure is for a local school district the equivalent figure from Franklin County will be used.

(ii) If the missing figure is for a city, exempted village, or joint vocational school district the program will generate the necessary data using as a basis figures for the first county (in the series of 88 counties) on which data are given for local school districts as well as for the type of school district(s) on which data are sought.

The annual academic school cost per pupil for local school districts is multiplied by the following ratio:

$$\frac{O_i}{L_i}$$

where:

O_i = annual academic school cost per pupil for the type(s) of school district for which data are sought,

L_i = annual academic school cost per pupil for local school districts,

i = first county in the series of 88 counties where data are given for local school districts as

well as for the type of school district(s) on which data are sought.

---

(53) SOCIAL COSTS OF TRAINING THE VOCATIONAL GRADUATE (METHOD II)

[(16) - (52)] x (5)

---

(54) PRIVATE COSTS OF TRAINING THE VOCATIONAL GRADUATE (METHOD II)

(40) x (5)

---

(55) SOCIAL PRESENT VALUE AND SOCIAL RATE OF RETURN (METHOD II)

(See Appendix IV: Subprogram for Calculation of Present Value and Rate of Return)

---

(56) PRIVATE PRESENT VALUE AND PRIVATE RATE OF RETURN (METHOD II)

(See Appendix IV: Subprogram for Calculation of Present Value and Rate of Return)

IV

APPENDICES

Appendix I	Procedure for Keying Information
Appendix II	Subprogram for Calculation of Lifetime Labor Force Participation Rates
Appendix III	Subprogram for Calculation of Age-Specific Probability of Survival
Appendix IV	Subprogram for Calculation of Present Value and Rate of Return
Appendix V	Geographical Location Codes
Appendix VI	List of Vocational Program Taxonomy Codes
Appendix VII	Data Formats

APPENDIX I

PROCEDURE FOR KEYING INFORMATION

This appendix describes the procedure to be followed in introducing "keyed" information, i.e. information that needs to be fed into the program in order to obtain the desired computations.

The following table lists the information which must be keyed and the column spaces to be used on computer cards. For convenient reference, the appropriate item number in the Program Procedure is also shown, where applicable.

Program Procedure Item Number	Information to Be Keyed	Computer Card Column(s)
1	TAXONOMY CODE	1-6
13	SCHOOL DISTRICT TYPE	10
5	DURATION OF VOCATIONAL PROGRAM (YEARS)	15
17	GEOGRAPHICAL LOCATION CODE	
	2-digit code	19-20
	3-digit code	18-20
36	SEX CODE	25
	MULTIPLE COUNTY SPECIFICATION	30
	LABEL	35-80

The following three examples illustrate the procedure to be followed in introducing this keyed information:

Example 1

Computation of social and private rates of return and present value for:

PROGRAM: Agricultural Mechanics

TYPE OF SCHOOL DISTRICT: City School District

DURATION OF THE PROGRAM (YEARS): Two Years

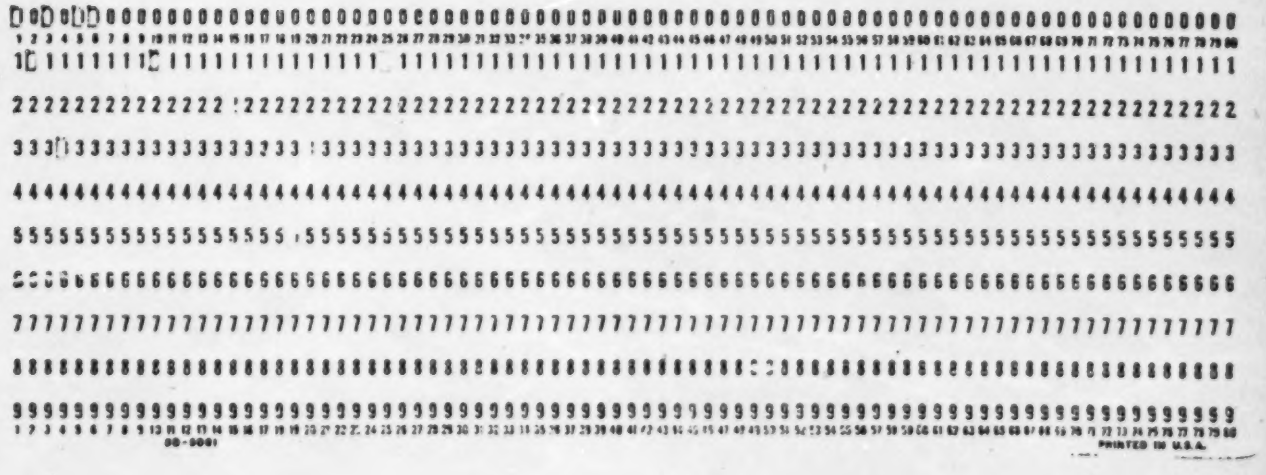
GEOGRAPHICAL LOCATION: Meigs County

SEX: Male

The numbers 010300 (taxonomy code for Agricultural Mechanics) are to be punched in columns 1-6. The code for a local school district (1) is to be punched in column 10. The duration of the program in years (2) is to be punched in column 15. The code for Meigs County (53) is to be punched on columns 19-20 and the sex code for males (1) is to be punched in column 25.

The punched card will look as follows:

010300 1 2 53 1



Example 2

Computation of social and private rates of return and present value for:

PROGRAM: Agricultural Mechanics

TYPE OF SCHOOL DISTRICT: City School District

DURATION OF PROGRAM (YEARS): Two Years

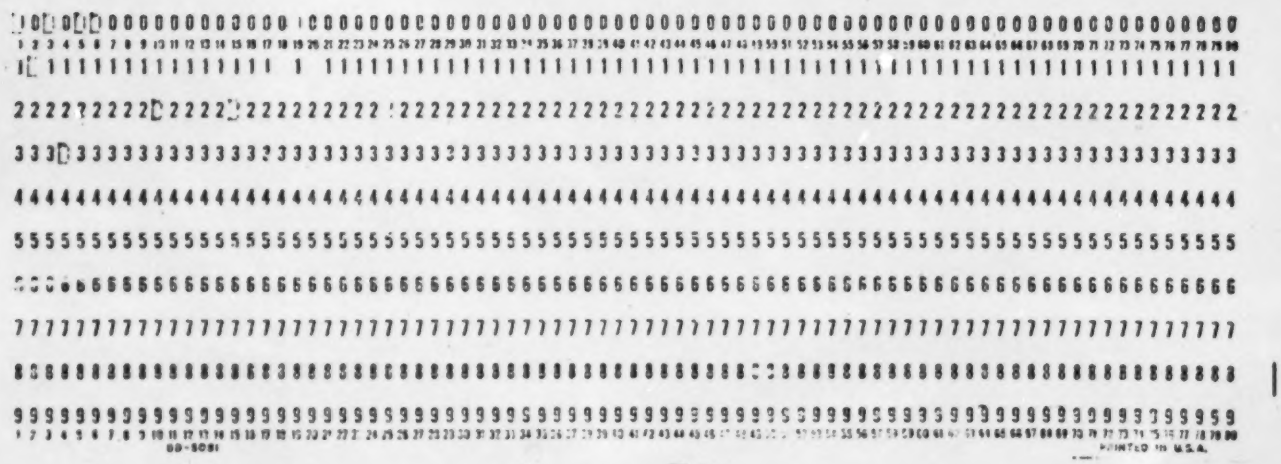
GEOGRAPHICAL LOCATION: Springfield

SEX: Female

The figure 01300 (taxonomy code for Agricultural Mechanics) is to be punched in columns 1-6. The number 2 (the code for a city school district) is to be punched in column 10. The number 2 (duration of the program in years) is to be punched in column 15. The figure 101 (the geographical location code for Springfield SMSA) is to be punched in columns 18-20. The figure 2 (the sex code for females) is to be punched in column 25.

The punched card will look as follows:

010300 2 2 101 2



Example 3

Computation of social and private rates of return and present value for:

PROGRAM: Agricultural Mechanics

TYPE OF SCHOOL DISTRICT: Joint Vocational School

DURATION OF PROGRAM (YEARS): Two Years

GEOGRAPHICAL LOCATION: Montgomery Joint Vocational School District (Miami, Montgomery, Preble, and Warren counties)

SEX: Females and Males Combined

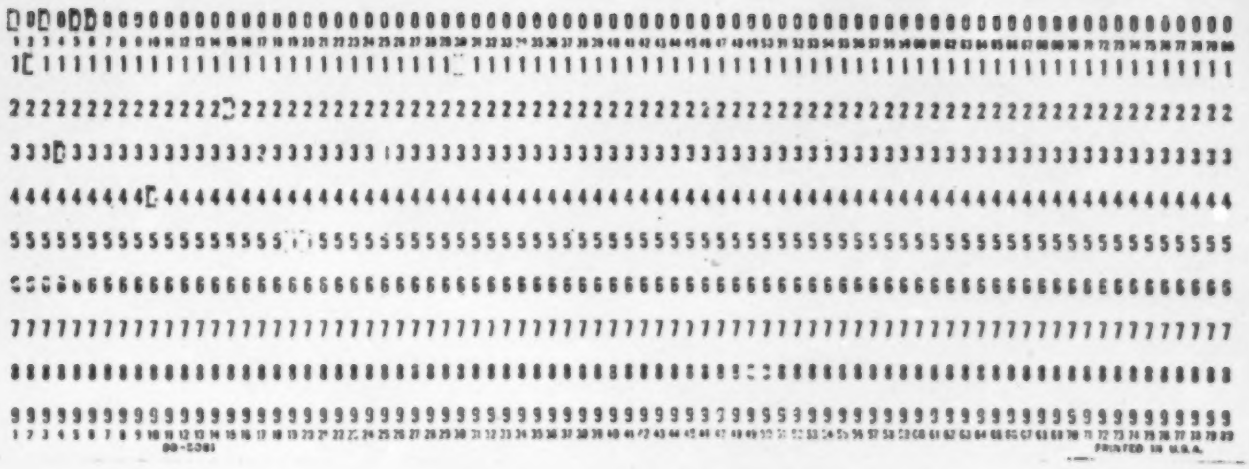
Since the geographical region for which the calculations are desired includes more than one regional unit (county or SMSA), a separate card is to be punched for each of the counties comprising the geographical region. Each of the cards is to have the same information punched except for the appropriate county code.

On each of the four cards: the numbers 010300 (taxonomy code for Agricultural Economics) are to be punched in columns 1-6. The number 4 (the code for a joint vocational school district) is to be punched in column 10. The number 3 (duration of the program in years) is to be punched in column 15. The figure 3 (the sex code for females and males combined) is to be punched in column 25. In addition, the number 1 is to be punched in column 30 indicating a geographical region of more than one regional unit (county or SMSA).

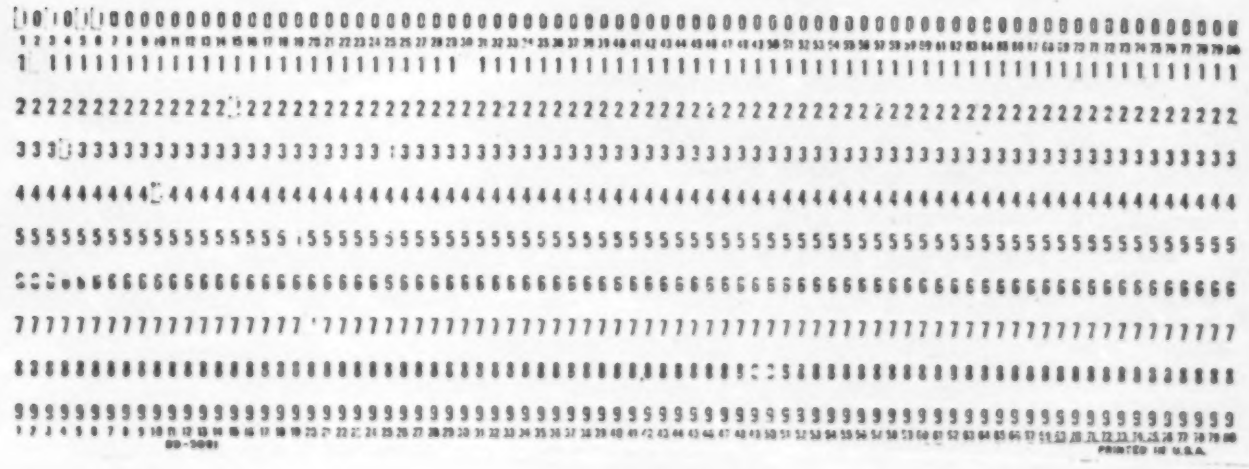
The appropriate county code for each of the four counties is to be punched in columns 19-20; the figure 55 for Miami County, 57 for Montgomery County, 68 for Preble County and 83 for Warren County.

The four cards will look as follows:

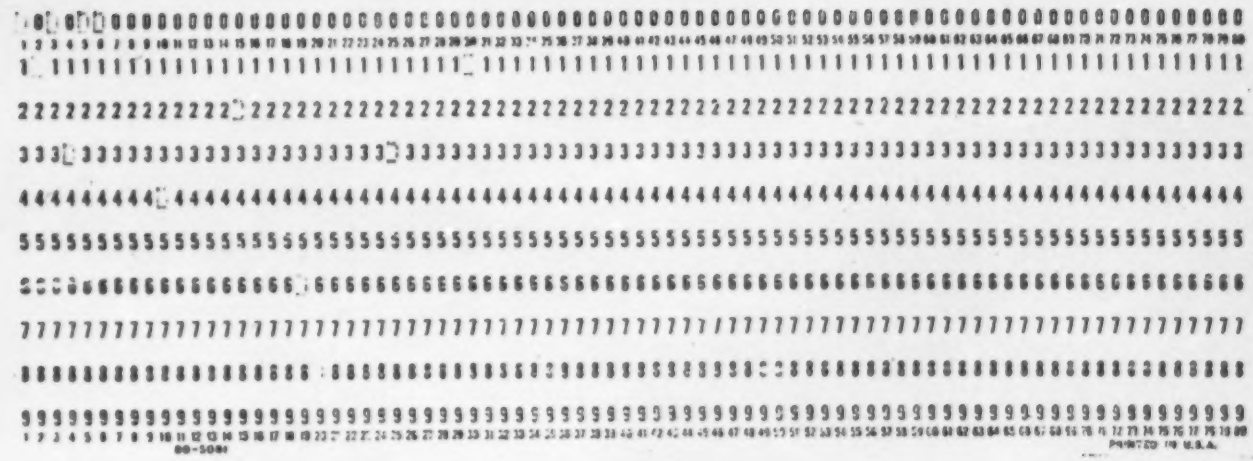
```
010300   4    2   55    3    1
```



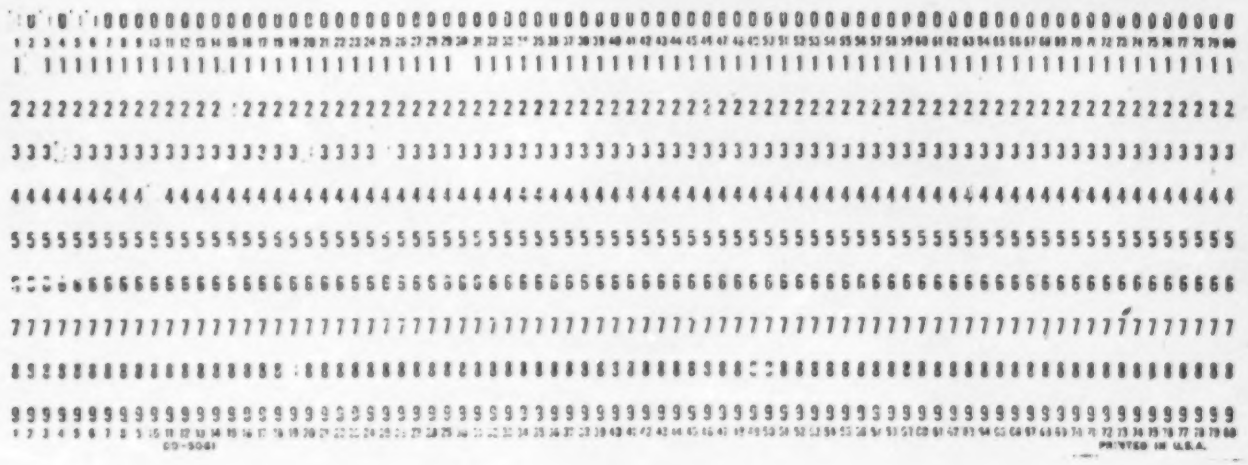
```
010300   4    2   57    3    1
```



010300 4 2 63 3 1



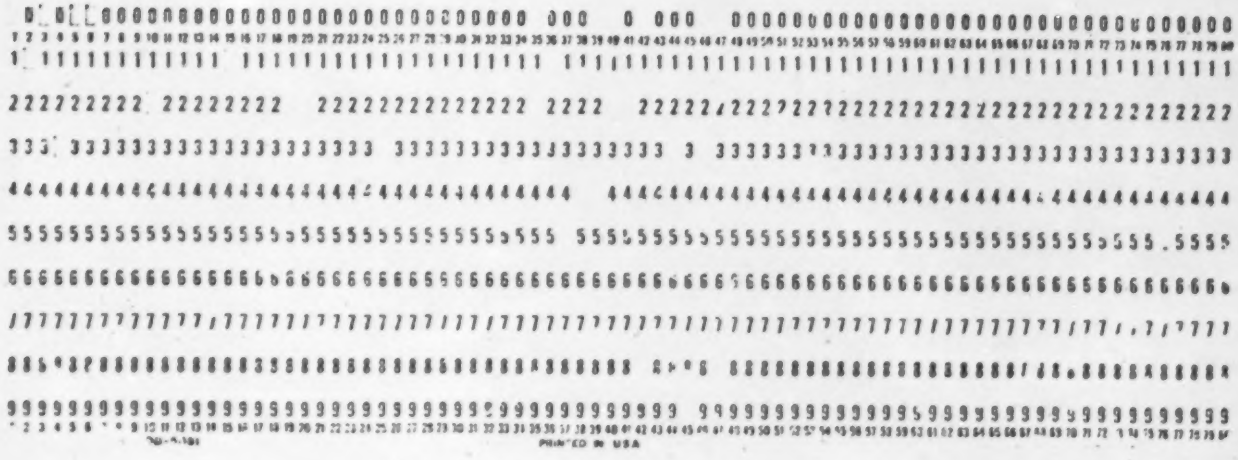
010300 4 2 83 3 1



The subprogram will generate rate of return and present value calculations for each of the counties as specified as well as for the four-county region. The region figures will be based on the component figures for the four counties weighted by population.

In all cases a label heading on the computer output reporting the calculations may be obtained by punching the information (county name, school district, etc.) in columns 35-80. An example of such a label appears below:

```
010300  2    1   22    3          SANDUSKY CITY
```



APPENDIX II

SUBPROGRAM FOR CALCULATION OF

LIFETIME LABOR FORCE PARTICIPATION RATES

The subprogram calculates the lifetime labor participation rate by age, sex, and county.

Labor force participation rate (LFPR) data (see item 37, Program Procedure) are listed by county for males and females and by age group.

The subprogram uses the following age groups (as relevant to the calculation of present value and rates of return):

18 and 19

20 and 21

22 - 24

25 - 34

35 - 44

45 - 64

For specific ages 18 through 64 the LFPR corresponding to the appropriate age interval is used in the subprogram. The county population and death data, which must be meshed with LFPR data tocalculate the age-specific effective participation rates, are given in the following ten age intervals:

(i)	15 - 19	(vi)	40 - 44
(ii)	20 - 24	(vii)	45 - 49
(iii)	25 - 29	(viii)	50 - 54
(iv)	30 - 34	(ix)	55 - 59
(v)	35 - 39	(x)	60 - 64

The Subprogram automatically subdivides the 6 LFPR age intervals (as entered in the data bank) into the above 10 age intervals.

In the calculation of present value and rate of return in the information sought is for males and females combined (see Program Procedure, item No. 36), the subprogram weights each LFPR by the sex distribution of the population in the county using the following formula:

$$LFPR_i = \frac{(MLFPR_i \times MPOP_i) + (FLFPR_i \times FPOP_i)}{(MPOP_i + FPOP_i)}$$

$$i = 1, 2, \ldots, 10$$

Where:

LFPR = combined male and female labor force participation rate

MLFPR = male labor force participation rate

MPOP = male population

FLFPR = female labor force participation rate

FPOP = female population

i = age interval

APPENDIX III

SUBPROGRAM FOR CALCULATION OF

AGE-SPECIFIC PROBABILITY OF SURVIVAL

The subprogram calculates the age-specific probability of survival by age, sex, and county. The calculation is performed in 3 steps:

(1) Calculation of number of deaths by sex and county for each of the following 10 age groups:

(i)	15 - 19	(vi)	40 - 44
(ii)	20 - 24	(vii)	45 - 49
(iii)	25 - 29	(viii)	50 - 54
(iv)	30 - 34	(ix)	55 - 59
(v)	35 - 39	(x)	60 - 64

The resident deaths data (see item 38, Program Procedure) are given by sex, color (white and non-white) and age group for each county. The subprogram calculates male and female deaths by county for each of the age intervals using the following formula:

$$\overline{D^m} \text{ or } \overline{D^f} = \frac{(D_i^w \cdot P_i^w) + (D_i^n P_i^n)}{(P_i^w + P_i^n)}$$

$$i = 1,2,\ldots,10$$

where:

$\overline{D^m}$ or $\overline{D^f}$ = male or female deaths

D^w = white male deaths

D^n = non-white deaths

P^w = white population

P^n = non-white population

i = age interval

In the calculation of present value and rate of return, if the information sought is for males and females combined (see Program Procedure, item 37), the subprogram calculates deaths by county for males and females combined using the following formula:

$$\overline{D_i} = \frac{D_i^m + D_i^f}{2}$$

$$i = 1,2,\ldots,10$$

where:

$\overline{D}$ = average deaths, male and female combined

D^m = male deaths

D^f = female deaths

i = age interval

(2) Calculation of age-specific deaths and population by sex and county:

Population and death data by sex and county are broken up into specific age categories: 47 categories in the case of males (age 18 through age 64) and 44 for females (age 18 through age 61).

In the calculation of age-specific deaths and population, the number of deaths and population are distributed equally between years within each of the 10 age intervals.

(3) Calculation of the age-specific probability of survival by sex and county:

Age-specific probability of survival is calculated by a method of partial products for ages 18 through 61 for females and ages 18 through 64 for males as well as for males and females combined.

The following formula is used in the calculation:

$$S_i = \prod_{i=18}^{n} \left[1 - \frac{Di}{Pi}\right]$$

i = 18,19,...,61 for females

i = 18,19,...,64 for males and males and females combined

where:

S = age-specific probability of survival

D = deaths (female, male, or male and female combined)

P = population (female, male, or male and female combined)

i = age

APPENDIX IV

SUBPROGRAM FOR CALCULATION

OF PRESENT VALUE AND RATE OF RETURN

The subprogram calculates the present value of, and rate of return on investment in the vocational education of an individual using two measures:

(i) Method I (the dropout prevention option) measures the value of an investment in the vocational training of an individual who otherwise would drop out of high school and enter the labor market upon completion of the 10th grade.

(ii) Method II (the academic education option) which measures the value of an investment in the vocational training of an individual in lieu of completing the 11th and 12th grades in an academic curriculum.

(i) METHOD I

(a) Present Value I

The following formula is used for the calculation of Present Value I (Present Value under Method I: the dropout prevention option):

$$V_0 = \sum_{t=1}^{n} \frac{B_1 \cdot [(1+d)^t]^{-1} \cdot EMP_t}{(1+i)^t} - C_0$$

$t = 1,2,\ldots,n$

$n = 44$ for females; 47 for males and for males and females combined

where:

V_0 = Present Value I (Social or Private)

B = Benefits (Social or Private)

C_0 = Costs (Social or Private)

EMP = Effective Labor Force Participation Rate (See Program Procedure, item No. 39)

i = Discount Rate (10% used in the subprogram)

n = Number of Working Years After Graduation from the Vocational Program (44 years for females, 47 for males and for males and females combined).

d = Rate of Decrease in Benefits Over Working Lifetime. Subprogram uses a rate of decrease such that benefits during the last year of working lifetime (period n) are reduced to 15% of benefits in the first year of working (period 1), i.e. $B_1 \cdot (1+d)^n = 0.15\, B_1$.

Therefore:

$$d = e^{\log[0.15(EMP_1/EMP_n)/n]_{-1}}$$

(b) Rate of Return I

The following formula is used for the calculation of Rate of Return I (the rate of return under Method I: the dropout prevention option):

$$F(r) = \sum_{t=1}^{n} \frac{B \cdot [(1+d)^t]^{-1} \cdot EMP_t}{(1+r)^t} - C = 0$$

where:

r = Rate of Return I (Social or Private)

B = Benefits (Social or Private)

C_0 = Costs (Social or Private)

EMP = Effective Labor Force Participation Rate (See Program Procedure, item No. 39)

n = Number of Working Years After Graduation from the Vocational Program (44 years for females, 47 for males and for males and females combined)

The subprogram solves for F(r) by iteration, using the Newton-Rophson Method. Under this method, the solution of F(r) is found by the following process:

$$r_{n+1} = r_n - \frac{F(r)}{F'(r)}$$

where:

$$F'(r) = \frac{\partial F(r)}{\partial r}$$

The equation states that if r_n is an approximation of the solution of F(r), then r_{n+1} is a better approximation of

$$F'(r) = -\,n \sum_{t=1}^{n} \frac{B \cdot [(1+d)^t]^{-1} \cdot EMP_t}{(1+r)^{t+1}}$$

The subprogram selects r_{n+1} as the solution for r when the difference between the figure for r_n and for r_{n+1} is less than 10^{-5} (or 0.00001).

(ii) METHOD II

(a) Present Value II

The following formula is used for the calculation of Present Value II (Present Value under Method II: the academic education option):

$$V_0 = \sum_{t=1}^{n} \frac{B_1 \cdot (1-\frac{t}{n}) \cdot EMP_t}{(1+i)^t} - C_0$$

$t = 1,2,\ldots,n$

$n = 5$ for females, males, and for males and females combined

where:

V_o = Present Value II (Social or Private)

B = Benefits (Social or Private)

C_0 = Costs (Social or Private)

EMP = Effective Participation Rate (See Program Procedure, Step No. 39)

i = Discount Rate (10% used in the subprogram)

n = Number of Working Years After Graduation from the Vocational Program during which Earnings Differential Between Vocational and Academic Education remain (5 years for females, males, and for males and females combined)

(b) Rate of Return II

The following formula is used for the calculation of Rate of Return II (the rate of return under Method II: the academic education option):

$$F(f) = \sum_{t=1}^{n} \frac{B \cdot (1-\frac{t}{n}) \cdot EMP_t}{(1+r)^t}$$

$t = 1,2,\ldots,n$

n = 5 for females, males, and for males and females combined

where:

r = Rate of Return II (Social or Private)

B = Benefits (Social or Private)

C_0 = Costs (Social or Private)

EMP = Effective Participation Rate (See Program Procedure, Step No. 39)

n = Number of Working Years After Graduation from the Vocational Program during which Earnings Differential Between Vocational and Academic Education remain (5 years for females, males, and for males and females combined)

The subprogram solves for F(r) by iteration, using the Newton-Rophson Method. Under this method, the solution of F(r) is found by the following process:

$$r_{n+1} = r_n - \frac{F(r)}{F'(r)}$$

where:

$$F'(r) = \frac{\partial F(r)}{\partial r}$$

The equation states that if r_n is an approximation of the solution of F(r), then r_{n+1} is a better approximation:

$$F'(r) = -\sum_{t=1}^{n} n \frac{B \cdot (1-\frac{t}{n}) \cdot EMP_t}{(1+r)^{n+1}}$$

The subprogram selects r_{n+1} as the solution for r when the difference between the figure for r_n and for r_{n+1} is less than 10^{-5} (or 0.00001).